PB89-189401

Crop Loss Due to the Ozone in New England

Rutgers Univ., New Brunswick, NJ

Prepared for:
Environmental Protection Agency, Washington, DC

1988

U.S. Department of Commerce
National Technical Information Service
NTIS

50272 - 101

REPORT DOCUMENTATION PAGE	1.REPORT NO. 600/9-89/007	2.	3 PB89-189401

4. Title and Subtitle
Crop Loss Due To Ozone in New England

5. Report Date
Completed Fall 1988

6.

7. Author(s)
Thomas J. Maldonato, Graduate Student

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Rutgers University
Dept. of ENvironmental Sciences
P. O. Box 231
New Brunswick, NJ 08903

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U. S. Environmental Protection Agency
Office of Cooperative Environmental Management
499 South Capitol Street, SW A101-F6
Washington, DC 20460

13. Type of Report & Period Covered
Technical Report

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

1302 CROP LOSS DUE TO OZONE in NEW ENGLAND

This report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U. S. Environmental Protection Agency. Ozone is known to damage crops and forests; a national estimate of it's detrimental effects on crops is 2-3 billion dollars per year. This paper attempts to quantify the economic losses in New England due to ozone exposure. The monitored ozone values for each of the New England States and their means are established. The major cash crops grown in the area and their cash values are also presented. Using the Weibull function, a dose-response calculation for specific crops, a dollar value for crop loss is calculated. The dollar value for four crops (corn, hay, tobacco, and sweet corn) is estimated at approximately 12 million dollars (for the 1986 growing season). The New England forest species that are sensitive to ozone damage are also presented. Based on the lack of established Weibull functions for the other cash crops grown in New England and the lack of a method to quantify the cash value of forest damage due to ozone, the conclusion of this paper is that the economic loss in New England due to ozone is at least 12 million dollars per year.

17. Document Analysis a. Document Descriptors

b. Identifier's/Open-Ended Terms

c. COSATI Field/Group

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

18. Availability Statement	19. Security Class (This Report) Unclassified	21. No. of Pages 23
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18)

OPTIMAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

Final
1302-81
1

Crop Loss Due To Ozone in New England

Thomas J. Maldonato

Disclaimer

This report was furnished to the U. S. Environmental Protection Agency by the graduate student identified on the cover page, under a National Network of Environmental Policy Studies fellowship.

The contents are essentially as received from the author. The opinions, findings, and conclusions expressed are those of the author and not necessarily those of the Environmental Protection Agency. Mention, if any, of company, process, or product names is not to be considered as an endorsement by the U. S. Environmental Protection Agency.

Ozone is known to damage crops and forests and a national estimate of its detrimental effects on crops is 2-3 billion dollars per year. This paper attempts to quantify the economic losses in New England due to ozone exposure. The monitored ozone values for each of the New England States and their means are established. The major cash crops grown in the area and their cash value are also presented. Using the Weibull function, a dose-response calculation for specific crops, a dollar value for crop loss is calculated. The dollar value for five crops, corn, hay, tobacco, and sweet corn, the only species grown in New England for which there are established Weibull functions, is estimated at approximately 12 million dollars (for the 1986 growing season). The New England forest species that are sensitive to ozone damage are also presented. Based on the lack of established Weibull functions for the other cash crops grown in New England and the lack of a method to quantify the cash value of forest damage due to ozone, the conclusion of this paper is that the economic loss in New England due to ozone is at least 12 million dollars per year.

Research and field observations indicate that O_3 [ozone] alone or in combination with SO_2 [sulfur dioxide] and nitrogen dioxide (NO_2) is responsible for up to 90% of the crop loss in the U.S. caused by air pollution (1). Economic assessments of crop loss due to ozone have been conducted for various geographic areas and a variety of crops. Olszyk et al. conducted an assessment of the effects of ozone on crop productivity in the state of California. In order to conduct a valid study, one must first quantify the species of crops grown in a region of interest. Then a set of ozone values must be reviewed to decide which stations best describe the area of interest, i.e. agriculturally located stations. Research work on particular crops of interest must be gathered and reviewed to determine their value to the assessment. Crop production and its cash value must also be obtained for the area to be assessed. Once these are obtained then an assessment can be conducted.

When quantifying a region's crops and tree species many resources can be utilized. For the New England area, the New England Agricultural Statistics were obtained and condensed into Table 1. The data presents crop production for the major crops in the New England area. After a conversation with the New England statistician it was discovered that the Department of Agriculture for New England is unable to obtain the data needed to track all of the crop production in the area. The Department of Agriculture for New England does include major crops for the New England Area with a breakdown for each state in its listing.

Table 1. New England Crop Summary

CONNECTICUT CROPS - ACREAGE, PRODUCTION AND VALUE, 1986 AND 1987

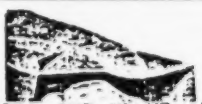
CROPS	ACRES HARVESTED		YIELD PER ACRE		UNIT	PRODUCTION		VALUE OF PRODUCTION 1/	
	1986	1987	1986	1987		1986	1987	1986	1987
						1,000		1,000 Dollars	
Corn for Silage	51,000	50,000	20.0	18.0	Ton	1,020	900	27,540	26,100
Hay, All	86,000	88,000	2.43	2.26	Ton	209	199	19,855	19,104
Potatoes	900	500	236	220	Cwt.	212	110	1,442	748
Tobacco									
Broadleaf	1,000	930	1,750	1,725	Pound	1,750	1,604	3,150	n/a
Shade	990	870	1,325	1,260	Pound	1,312	1,096	17,187	n/a
All 3/	1,990	1,800	1,539	1,500	Pound	3,062	2,700	20,337	17,085
Apples, Com'l 2/	---	---	---	---	42-Pound	1,095	1,024	8,869	9,331
Peaches 2/	---	---	---	---	48-Pound	54	52	1,248	1,300
Pears 2/	---	---	---	---	Ton	1.60	1.45	776	725
Sweet Corn	4,600	4,400	76	'71	Cwt.	359	312	6,283	4,711
STATE TOTAL	144,490	144,700	---	---	---	---	---	86,350	79,104

1/ Relates to marketing season or crop year.
2/ Production is the quantity sold or utilized.
3/ Preliminary 1987 value of production.

MAINE CROPS - ACREAGE, PRODUCTION AND VALUE, 1986 AND 1987

CROPS	ACRES HARVESTED		YIELD PER ACRE		UNIT	PRODUCTION		VALUE OF PRODUCTION 1/	
	1986	1987	1986	1987		1986	1987	1986	1987
						1,000		1,000 Dollars	
Corn for Silage	34,000	32,000	14.0	16.0	Ton	476	512	12,138	12,288
Oats	40,000	38,000	65.0	75.0	Bushel	2,600	2,850	2,080	2,993
Hay, All	225,000	216,000	1.99	1.98	Ton	448	428	30,464	28,248
Potatoes	86,000	86,000	255	285	Cwt.	21,930	24,510	131,580	116,423
Maple Syrup	---	---	---	---	Gallon	6	5	178	193
Apples, Com'l 2/	---	---	---	---	42-Pound	2,048	1,762	16,505	14,800
Blueberries 3/	---	---	---	---	Pound	40,169	36,330	12,854	16,349
STATE TOTAL	385,000	372,000	---	---	---	---	---	205,799	191,294

1/ Relates to marketing season or crop year.
2/ Production is quantity sold or utilized.
3/ Preliminary 1987 value of production.



NEW HAMPSHIRE CROPS - ACREAGE, PRODUCTION AND VALUE, 1986 AND 1987

CROPS	ACRES HARVESTED		YIELD PER ACRE		UNIT	PRODUCTION		VALUE OF PRODUCTION 1/	
	1986	1987	1986	1987		1986	1987	1986	1987
						1,000		1,000 Dollars	
Corn for Silage	25,000	23,000	18.5	19.0	Ton	463	437	12,733	11,581
Hay, All	87,000	85,000	2.28	2.13	Ton	198	181	18,216	16,471
Maple Syrup	---	---	---	---	Gallon	60	47	1,674	1,607
Apples, Com'l 2/	---	---	---	---	42-Pound	1,190	1,190	9,982	10,000
STATE TOTAL	112,000	108,000	---	---	---	---	---	42,605	39,659

1/ Relates to marketing season or crop year.
2/ Production is the quantity sold or utilized.

MASSACHUSETTS CROPS - ACREAGE, PRODUCTION AND VALUE, 1986 AND 1987 Table 1. (cont)

CROPS	ACRES HARVESTED		YIELD PER ACRE		UNIT	PRODUCTION		VALUE OF PRODUCTION 1/	
	1986	1987	1986	1987		1986	1987	1986	1987
						1,000		1,000 Dollars	
Corn for Silage	36,000	34,000	18.0	18.5	Ton	648	629	18,144	17,298
Hay, All	127,000	127,000	2.56	2.29	Ton	325	291	29,250	26,481
Potatoes	2,900	2,800	230	235	Cwt.	667	658	4,469	4,376
Tobacco									
Outdoor Tobacco	130	110	1,925	1,775	Pound	250	195	400	n/a
Shade	340	410	1,095	1,280	Pound	372	525	4,873	n/a
All 3/	470	520	1,323	1,385	Pound	622	720	5,273	7,210
Maple Syrup	---	---	---	---	Gallon	30	28	753	890
Apples, Com'l 2/	---	---	---	---	42-Pound	2,190	2,238	18,048	20,586
Peaches 2/	---	---	---	---	48-Pound	38	42	864	1,040
Cranberries 4/	11,300	11,400	160.4	126.3	Barrel	1,813	1,440	93,732	74,448
Sweet Corn	8,400	7,100	94	90	Cwt.	790	639	13,625	10,096
Tomatoes	590	580	215	215	Cwt.	127	125	6,985	8,125
STATE TOTAL	186,660	183,400	---	---	---	---	---	191,343	170,550

1/ Relates to marketing season or crop year.
2/ Production is the quantity sold or utilized.
3/ Preliminary 1987 value of production.
4/ 1986 prices used to compute 1987 value of production.

RHODE ISLAND CROPS - ACREAGE, PRODUCTION AND VALUE, 1986 AND 1987

CROPS	ACRES HARVESTED		YIELD PER ACRE		UNIT	PRODUCTION		VALUE OF PRODUCTION 1/	
	1986	1987	1986	1987		1986	1987	1986	1987
						1,000		1,000 Dollars	
Corn for Silage	4,000	3,000	19.0	15.0	Ton	76	45	2,280	1,373
Hay, All	9,000	8,000	2.56	2.38	Ton	23	19	2,392	1,957
Potatoes	1,600	1,500	240	175	Cwt.	384	263	2,227	1,486
Apples, Com'l 2/	---	---	---	---	42-Pound	131	119	1,224	1,195
STATE TOTAL	14,600	12,500	---	---	---	---	---	8,123	6,011

1/ Relates to marketing season or crop year.
2/ Production is the quantity sold or utilized.

VERMONT - ACREAGE, PRODUCTION AND VALUE, 1986 AND 1987

CROPS	ACRES HARVESTED		YIELD PER ACRE		UNIT	PRODUCTION		VALUE OF PRODUCTION 1/	
	1986	1987	1986	1987		1986	1987	1986	1987
						1,000		1,000 Dollars	
Corn for Silage	90,000	87,000	14.0	16.0	Ton	1,260	1,392	30,870	34,104
Hay, All	440,000	410,000	2.13	2.08	Ton	938	851	71,288	66,378
Potatoes 3/	100	---	200	---	Cwt.	20	--	136	---
Maple Syrup	---	---	---	---	Gallon	338	275	8,687	8,388
Apples, Com'l 2/	---	---	---	---	42-Pound	1,143	976	8,480	7,462
STATE TOTAL	530,100	497,000	---	---	---	---	---	119,461	116,332

1/ Relates to marketing season or crop year.
2/ Production is the quantity sold or utilized.
3/ Vermont potato estimate discontinued 1987.

The Crop Summary includes 1986 and 1987 values for comparison, also including acres harvested, yield per acre, production, and production value.

Raw ozone data is necessary to calculate an ozone value for an area to be assessed. The raw data used in this assessment was obtained from the Environmental Protection Agency's Aerometric Information Retrieval System (AIRS). This data provides an ozone value for a particular site every hour on the hour, unless the station was not in operation. Sites used in the assessment were selected by their geographical location. If a site was within city limits, or near a major highway, it was not included. The data is manipulated by taking the monthly sets of data and calculating a 7-hour/day period between 0900 and 1600 hours. As ozone is a diurnal pollutant, this time period is when the daily ozone values are likely to be at their greatest value and the plants are most responsive. The 7-h period (0900-1600, Standard Time) was chosen to include the hours when plants are generally the most physiologically active and O_3 concentrations are usually the highest (2). The 7-hour/day mean ozone values, from 1987, for each site are presented in Appendix A, with state, city, setting, and land use information. One crop, tomatoes, required a 12-hour/day period between 0800 and 2000 hours. The 12-hour/day data is included in Appendix A, it was also obtained from the AIRS data. The sites were plotted on maps of the region to get an idea of the distribution of the sites. Ozone values for each state are calculated and the standard deviation is shown

in Table 2. This shows the variability of using a state wide ozone value for crop assessment.

One source of variability in the sites is that most sites are located in cities, or populated areas, not in agricultural areas. That does not infer that the true ozone values in an agricultural area are going to be less than a populated area but a standard state can not be justified. Even though the sites located in cities were omitted, the sites used in the calculation of a state ozone value are not all located in agricultural regions. In this assessment there was no choice but to consider the data and to figure an ozone value for each state to be used in the functions used to calculate a loss.

The National Crop Loss Assessment Network (NCLAN) was introduced by the EPA to assess crop loss due to air pollution.

> The primary objectives of the NCLAN are:
> 1. To define the relationships between yields of major agricultural crops and doses of O_3, SO_2, NO_2, and their mixtures as required to satisfy the needs of the economic assessment and to support the development of NAAQS;
> 2. to assess national primary economic consequences resulting from the exposure of major agricultural crops to O_3, SO_2, NO_2, and their mixtures;
> 3. to advance the understanding of the cause and effect relationships that determine crop response to pollutant exposure (1).

The NCLAN sponsors many research projects to assess the crop loss due to ozone and other air pollutants. The 7-hour/day value described earlier was accepted by the NCLAN as a value to be used in calculating a dose-response function.

Table 2. 7/hour mean ozone values

State	Ozone calc.	Std. Dev	n
Connecticut	0.051 ppm	0.0032	7
Maine	0.040 ppm	0.0029	10
Massachusetts	0.042 ppm	0.0030	11
New Hampshire	0.041 ppm	0.0040	3
Rhode Island	0.054 ppm	----	1
Vermont	0.040 ppm	0.0008	2

note:
Ozone calc. = Ozone value used in the Weibull for crop yield.
Std. Dev = Standard Deviation.
n = number of stations where ozone data were obtained.

Table 3. New England 1987 Crop Reduction Values for the Selected Crops

	Ambient	MA	ME	CT	NH	VT	RI
O3 Value	Ambient	0.042	0.040	0.041	0.051	0.040	0.054
Hay	4101	3856	3904	3881	3560	3904	3429
%red.		6.0	4.8	5.4	13.2	4.8	16.4
$ Lost		1581748	1359647	1026763	2173513	3194939	320784
Corn 3780	11118	10958	10986	10973	10798	10986	10730
%red.		1.4	1.2	1.3	2.9	1.2	3.5
$ Lost		248209	145720	341210	333698	404430	47958
Corn 397	12149	12126	12131	12128	12089	12131	12071
%red.		0.2	0.2	0.2	0.5	0.2	0.6
$ Lost		33182	18437	44375	56860	51169	8826
Tobacco	316	305	306	306	296	306	293
%red.		3.6	3.0	3.3	6.2	3.0	7.2
$ Lost		256146	---	561786	---	---	---
Wheat	4703	3557	3694	3625	3002	3694	2836
%red.		24.4	21.5	22.9	36.2	21.5	39.7
$ Lost		---	22314	5502	---	6437	---
12/hour ozone		0.039	0.039	0.047	0.039	0.038	0.049
Sweet Cor	294	283	283	276	283	283	274
%red.		3.9	3.9	6.1	3.9	3.6	6.7
$ Lost		3898	---	288	---	---	---

notes:
Ambient = 0.025 ppm.
%red. = percent reduction for each crop
$ Lost = Dollar amount lost due to ozone in each particular state.

The Weibull model is used to describe crop yield due to ozone effects for a variety of reasons:

1. It has a flexible form that covers the range of responses observed.
2. The form of the Weibull is biologically realistic.
3. The parameters of the Weibull have straight-forward interpretations.
4. The Weibull provides direct estimates of proportional yields.
5. Tests of homogeneity of proportional yield responses over data sets are readily accomplished (3).

The Weibull is a function involving derivatives and parameters which must be experimentally derived. Using data from experiments and the Weibull function, dose-response functions can be calculated. The dose-response functions can be used to create dose-response curves, where the X-axis is the ozone value and the Y-axis is percent reduction. Once a dose response curve is created, a corresponding percent reduction can be found for any ozone value.

The Weibull function can also be used for any specific ozone value simply by inserting the ozone value and calculating a response. In order to compare the Weibull functions, the NCLAN has used the Weibull calibrated to 0.025 ppm ozone which is an accepted background ozone value with no anthropogenic addition (1). The Weibull has been used and dose-response functions calculated for most research conducted since 1984. This limits the assessment to research conducted in the past four years.

While obtaining research articles and contacting authors it was discovered that for most of the crops included in the New England Crop Summary, no research was conducted. Most crops

which have been studied have been major production crops. The New England Crop Summary only contained four crops which have been researched. Weibull functions had only been produced for three of the four crops which had been researched.

This put severe restrictions on the assessment mainly because it now only includes three of the major crops produced in the New England Region. The Weibull functions are described for each crop below:

Corn "PAG 397" (4).

$$yield = 12151 \exp[-(x/0.161)^{4.544}]$$

Corn "Pioneer 3780" (4).

$$yield = 11159 \exp[-(x/0.155)^{3.071}]$$

Hay (5).

$$yield = 4140 \exp[-(x/0.083)^{3.882}]$$

Tobacco (6).

$$yield = 322 \exp[-(x/0.165)^{2.12}]$$

There were two additional crops that had comparable functions created for them. They are presented below:

Wheat (7).

$$yield = 7857 \exp[-(x/0.053)^{1.0}]$$

Sweet Corn (7).

$$yield = 315.02 - (829.9 \times 12h)$$

The yield values for each crop are calculated at a pseudo ambient ozone level of 0.025 ppm and then at the value for that

particular state, from the 1987 ozone data. Once the two values are calculated a percent loss can be figured. Then using the percentage loss for each crop and state, and the production value from the 1986 New England Crop Summary, a rough estimate of the economic loss can be determined. The crop losses and percent loss is presented in Table 3.

The assessment shows that for the five crops studied there was a loss of approximately twelve million dollars for the 1986 growing season. The reason that two species of corn were used is to explain that the exact cultivar of corn is unknown. In Table 3, the percent loss is different for each of the corn cultivars. This presents the need to know the exact cultivar being produced in a study area. One way of getting around this is to find an accepted common Weibull response for the particular crop being studied. There wasn't an available common Weibull response function for corn.

A state wide ozone value is used because the crop production is on a state basis. The Census Bureau conducts county level crop production every five years. This can be used, but the ozone data has to be from the same year that the county data is derived. Ozone data from 1987 and crop production from 1983 cannot be used in the same assessment. For rough assessments, ozone data and crop data from different years can be utilized. If crop production values on a county level are used, then ozone values must also be calculated on the county level to be used in an assessment.

Table 4 was created to summarize the crop values used in the calculations of crop loss. The values are taken from Table 1. Table 5 is a summary of the crop losses in each state to derive a statewide economic loss, and to be able to determine which states suffer the greatest from increased ozone levels. When viewing Table 5 it should be reminded that the study does not include various crops for lack of information, i.e. potatoes, no function describing loss could be located.

Assessing ozone damage to trees was difficult to explore. There is a lack of research data on the effects of ozone on tree species. For this assessment table 6 was constructed using forest statistics from Connecticut, Maine, New Hampshire, and Vermont (8, 9, 10, 11). Statistics for Massachusetts and Rhode Island were not obtained and therefore are not included. The U.S. Department of Agriculture Forest Service produces publications for each state "Forest Statistics" for any state. The publications include many statistics for tree production in the particular state. The publication also includes a list of the trees known to exist in the states, and their frequency. The tree listing is duplicated in table 6. Table 6 includes the occurrence, and the ozone sensitivity of the particular tree. The trees are listed in order of ozone sensitivity. Because there isn't an ozone sensitivity listed for the trees located at the bottom of the list does not mean that they are not damaged by ozone. It means that no ozone sensitivity data was found for that tree specie. They are included to give a complete inventory

Table 4. 1987 Crop Values (1,000 Dollars)

	Corn	Hay	Tobacco	Wheat	Sweet Corn
MA	17298	26481	7210	---	101
ME	12288	28248	---	104	---
CT	26100	19104	17085	24	5
NH	11581	16471	---	---	---
VT	34104	66378	---	30	---
RI	1373	1957	---	---	---

Table 5. Crop Loss for each State

Crop	MA	ME	CT	NH	VT	RI
Hay	1581748	1359647	1026763	2173513	3194939	320784
Corn 3780	248209	145720	341210	333698	404430	47958
Corn 397	33182	18437	44375	56860	51169	8826
Tobacco	256146	---	561786	---	---	---
Wheat	---	22314	5502	---	6437	---
Sweet Cor	3898	---	288	---	---	---
State Tot	2123183	1546118	1979924	2564071	3656975	377568

New England Total 12247839

of the tree species in each state.

There are many problems trying to create ozone sensitivity data for trees. Most of the research includes ozone sensitivity for seedlings, they are easier to monitor that full grown trees. The problem with using full grown trees is how to dispense the ozone and how long to monitor for results. The difficulties are obvious in trying to expose full grown trees to ozone in a chamber. It is difficult to determine that a particular specie of tree is very sensitive to ozone and correlate that to a full grown tree. This is one of the reasons that table 6 only includes whether the specie is sensitive, intermediate, or tolerant.

Most of the research has been conducted in this field. The remaining articles being published will decrease according to Robert Kohut, a leading crop loss research scientist.

The assessment included deriving site sampled ozone values, equating different functions to assess the loss due to ozone, and calculating an economic loss for each crop. The ozone values could have been more sound if a statistical analysis was conducted to discover if the averaging of site values is valid. The overall assessment concludes that in the New England states there is a 12 billion dollar loss due to ground level ozone. The assessment for trees did not arrive at an economic value for the loss but does show, from Table 6, that the trees in the New England states are sensitive to ozone.

Table 6. State Tree compilation, occurrence and sensitivity.

Connecticut Trees Species	Occurrence	O3 sens.
Ailanthus	vr	S
Eastern white pine	c	S
Green ash	vr	S
Quaking aspen	r	S
Sycamore	vr	S
White ash	c	S
White oak	vc	S
Apple	r	I
Black oak	c	I
Pin oak	r	I
Pitch pine	r	I
Scarlet oak	c	I
Scotch pine	r	I
Black locust	r	T
Eastern hemlock	vc	T
Flowering dogwood	r	T
Northern red oak	vc	T
Norway spruce	r	T
Red maple	vc	T
Red pine	r	T
Sugar maple	c	T
American basswood	r	
American beech	c	
American chestnut	vr	
American elm	c	
American hornbeam	r	
Atlantic white-cedar	vr	
Bigtooth aspen	r	
Black ash	r	
Black cherry	c	
Blackgum	r	
Butternut	vr	
Chestnut oak	c	
Eastern cottonwood	r	
Eastern hophornbeam	r	
Eastern redcedar	c	
Gray birch	r	
Hickory	c	
Northern white-cedar	vr	
Paper birch	c	
Pin cherry	vr	
Sassafras	c	
Slippery elm	vr	
Striped maple	vr	
Swamp chestnut oak	vr	
Sweet birch	vc	
Yellow birch	c	
Yellow-poplar	r	

notes:
Occurrence: in decreasing order.
vc - very common; c - common;
r - rare; vr - very rare.

Ozone Sens.: Ozone sensitivity
S - Sensitive;
I - Intermediate;
T - Tolerant.

Table 6. State Tree compilation, occurrence and sensitivity. (cont.)

Maine Trees Species	Occurrence	O3 sens.
Ailanthus	vr	S
Eastern white pine	c	S
Green ash	r	S
Quaking aspen	c	S
White ash	c	S
White oak	r	S
Apple	r	I
Black oak	r	I
Pitch pine	vr	I
Scarlet oak	vr	I
Willow	vr	I
Balsam fir	vc	T
Black locust	vr	T
Black spruce	c	T
Eastern hemlock	c	T
Northern red oak	c	T
Norway spruce	vr	T
Red maple	vc	T
Red pine	r	T
Sugar maple	c	T
White birch	vc	T
White spruce	c	T
American basswood	r	
American beech	c	
American elm	r	
American hornbeam	vr	
Balsam poplar	r	
Bigtooth aspen	c	
Black ash	c	
Black cherry	r	
Black willow	vr	
Blackgum	vr	
Brown ash	c	
Butternut	vr	
Eastern hophornbeam	r	
Eastern redcedar	vr	
Gray birch	c	
Hickory	vr	
Mountain maple	vr	
Northern white-cedar	vc	
Pin cherry	r	
Red ash	r	
Red spruce	vc	
Silver maple	vr	
Slippery elm	vr	
Striped maple	c	
Sweet birch	vr	
Tamarack	c	
Yellow birch	c	

notes:
Occurrence: in decreasing order.
vc - very common; c - common;
r - rare; vr - very rare.

Ozone Sens.: Ozone sensitivity
S - Sensitive;
I - Intermediate;

Table 6. State Tree compilation, occurrence and sensitivity. (cont.)

New Hampshire	Occurrence	O3 sens.
Eastern white pine	vc	S
Green ash	vr	S
Quaking aspen	c	S
White ash	c	S
White oak	c	S
Apple	r	I
Pitch pine	c	I
Scarlet oak	r	I
Balsam fir	vc	T
Black spruce	r	T
Eastern hemlock	vc	T
Red maple	vc	T
Red pine	r	T
Sugar maple	vc	T
White birch	vc	T
White spruce	c	T
American beech	c	
Balsam poplar	r	
Bigtooth aspen	c	
Black ash	r	
Black cherry	c	
Butternut	r	
Eastern hophornbeam	r	
Eastern redcedar	r	
Gray birch	c	
Hickory	r	
Mountain maple	vr	
Northern white-cedar	r	
Pin cherry	r	
Red spruce	vc	
Silver maple	vr	
Striped maple	r	
Sweet birch	c	
Tamarack	r	
Yellow birch	vc	

notes:
Occurrence: in decreasing order.
vc - very common; c - common;
r - rare; vr - very rare.

Ozone Sens.: Ozone sensitivity
S - Sensitive;
I - Intermediate;
T - Tolerant.

Table 6. State Tree compilation, occurrence and sensitivity. (cont.)

Vermont	Occurrence	O3 sens.
Ailanthus	vr	S
Eastern white pine	vc	S
Green ash	r	S
Quaking aspen	c	S
White ash	c	S
White oak	r	S
Apple	r	I
Boxelder	vr	I
Balsam fir	vc	T
Black locust	vr	T
Black spruce	r	T
Black walnut	vr	T
Eastern hemlock	vc	T
Northern red oak	c	T
Red maple	vc	T
Red pine	r	T
Sugar maple	vc	T
White birch	vc	T
White spruce	c	T
American basswood	r	
American beech	vc	
American elm	c	
American hornbeam	vr	
Balsam poplar	vr	
Bigtooth aspen	r	
Black ash	r	
Black cherry	c	
Butternut	r	
Chestnut oak	vr	
Eastern cottonwood	vr	
Eastern hophornbeam	c	
Eastern redcedar	r	
Gray birch	c	
Hawthorn	vr	
Hickory	c	
Honeylocust	vr	
Northern white-cedar	c	
Pin cherry	r	
Red spruce	vc	
Silver maple	c	
Slippery elm	r	
Striped maple	c	
Swamp white oak	vr	
Sweet birch	c	
Tamarack	r	
Yellow birch	vc	

notes:
Occurrence: in decreasing order.
vc - very common; c - common;
r - rare; vr - very rare.

Ozone Sens.: Ozone sensitivity
S - Sensitive;
I - Intermediate;
T - Tolerant.

Works Cited

1. Heck, Walter W., O.C. Taylor, Richard Adams, Gail Bingham, Joseph Miller, Eric Preston, and Leonard Weinstein. "Assessment of Crop Loss from Ozone" Journal of the Air Pollution Control Association 32 (1982) : 353-61.

2. Heck, Walter W., William W. Cure, John O. Rawlings, Lawrence J. Zaragoza, Allen S. Heagle, Howard E. Heggestad, Robert J. Kohut, Lance W. Kress, and Patrick J. Temple. "Assessing Impacts of Ozone on Agricultural Crops: I. Overview" Journal of the Air Pollution Control Association 34 (1984) : 729-35.

3. Rawlings, J. O., and W. W. Cure. "The Weibull Function as a Dose-Response Model to Describe Ozone Effects on Crop Yields" Crop Science 25 (1985) : 807-14.

4. Kress, L. W., and J. E. Miller. "Impact of ozone on field-corn yield" Canadian Journal of Botany 63 (1985) : 2408-15.

5. Kohut, Robert J., John A. Laurence, and Robert G. Amundson. " Effects of Ozone and Sulfur Dioxide on Yield of Red Clover and Timothy" Submitted for publication.

6. Heagle, Allen S., W. W. Heck, V. M. Lesser, and J. O. Rawlings. "Effects of Daily Ozone Exposure Duration and Concentration Fluctuation on Yield of Tobacco" Phytopathology 77 (1987) : 856-62.

7. Olszyk, David M., Homero Cabrera, and C. Ray Thompson. "California Statewide Assessment of the Effects of Ozone on Crop Productivity" Journal of the Air Pollution Control Association 38 (1988) : 928-31.

8. U.S. Department of Agriculture Forest Service. "Forest Statistics for Connecticut-1972 and 1985"

9. U.S. Department of Agriculture Forest Service. "Forest Statistics for Maine-1971 and 1982"

10. U.S. Department of Agriculture Forest Service. "Forest Statistics for New Hampshire-1973 and 1983"

11. U.S. Department of Agriculture Forest Service. "Forest Statistics for Vermont-1973 and 1983"

Appendix A. 7-Hour/day mean ozone values

State: Massachusetts
County: Barnstable
City: Truro
Setting: Rural
Land Use: Residential

Hour	May	June	July	August	Sept.
9	0.040	0.044	0.040	0.032	0.027
10	0.041	0.046	0.042	0.034	0.028
11	0.043	0.050	0.046	0.036	0.030
12	0.045	0.054	0.048	0.038	0.032
1	0.047	0.054	0.049	0.041	0.035
2	0.047	0.054	0.050	0.042	0.038
3	0.047	0.054	0.049	0.042	0.040
4	0.045	0.053	0.049	0.043	0.040
Mean	0.044	0.051	0.047	0.039	0.034
		Site Mean	0.043		

State: Massachusetts
County: Bristol
City: Easton
Setting: Rural
Land Use: Residential

Hour	May	June	July	August	Sept.
9	0.043	0.043	0.037	0.035	0.024
10	0.046	0.050	0.043	0.043	0.028
11	0.049	0.053	0.048	0.046	0.034
12	0.051	0.054	0.047	0.050	0.038
1	0.053	0.056	0.050	0.051	0.040
2	0.053	0.057	0.051	0.052	0.042
3	0.051	0.056	0.048	0.051	0.038
4	0.050	0.057	0.046	0.050	0.034
Mean	0.050	0.053	0.046	0.047	0.035
		Site Mean	0.046		

State: Massachusetts
County: Bristol
City: Fairhaven
Setting: Suburban
Land Use: Residential

Hour	May	June	July	August	Sept.
9	0.045	0.042	0.036	0.034	0.028
10	0.047	0.046	0.040	0.039	0.032
11	0.049	0.049	0.043	0.042	0.035
12	0.050	0.051	0.047	0.047	0.039
1	0.051	0.053	0.048	0.048	0.040
2	0.052	0.056	0.049	0.045	0.039
3	0.052	0.056	0.046	0.044	0.039
4	0.053	0.055	0.045	0.043	0.038
Mean	0.050	0.051	0.044	0.043	0.036
		Site Mean	0.045		

State: Massachusetts
County: Essex
City: Lawrence
Setting: Urban and Center City
Land Use: Residential

Hour	May	June	July	August	Sept.
9	0.033	0.035	0.031	0.027	0.016
10	0.038	0.039	0.037	0.034	0.021
11	0.041	0.042	0.042	0.038	0.023
12	0.043	0.044	0.047	0.041	0.026
1	0.043	0.043	0.049	0.043	0.026
2	0.043	0.044	0.048	0.041	0.026
3	0.043	0.045	0.047	0.039	0.024
4	0.042	0.045	0.043	0.035	0.022
Mean	0.041	0.042	0.043	0.037	0.023
		Site Mean	0.037		

State: Massachusetts
County: Essex
City: Newburyport
Setting: Suburban
Land Use: Residential

Hour	May	June	July	August	Sept.
9	0.042	0.034	0.036	0.025	0.022
10	0.045	0.039	0.043	0.029	0.025
11	0.047	0.044	0.046	0.034	0.028
12	0.049	0.047	0.047	0.036	0.031
1	0.050	0.052	0.048	0.037	0.032
2	0.049	0.052	0.048	0.039	0.034
3	0.049	0.051	0.047	0.038	0.035
4	0.049	0.049	0.047	0.035	0.032
Mean	0.048	0.046	0.045	0.034	0.030
		Site Mean	0.041		

State: Massachusetts
County: Hampden
City: Agawam
Setting: Rural
Land Use: Agricultural

Hour	May	June	July	August	Sept.
9	0.034	0.034	0.034	0.027	0.021
10	0.040	0.038	0.038	0.033	0.027
11	0.044	0.041	0.042	0.039	0.031
12	0.047	0.043	0.043	0.044	0.032
1	0.048	0.044	0.044	0.046	0.033
2	0.049	0.043	0.046	0.045	0.033
3	0.050	0.044	0.047	0.045	0.032
4	0.046	0.043	0.045	0.045	0.030
Mean	0.045	0.041	0.042	0.041	0.030
		Site Mean	0.040		

State: Massachusetts
County: Hampden Setting: Suburban
City: Chicopee Land Use:Residential

Hour	May	June	July	August	Sept.
9	0.039	0.036	0.038	0.031	0.023
10	0.044	0.043	0.046	0.037	0.028
11	0.048	0.047	0.052	0.045	0.033
12	0.051	0.048	0.055	0.050	0.036
1	0.053	0.051	0.057	0.052	0.037
2	0.054	0.052	0.058	0.053	0.037
3	0.055	0.049	0.059	0.051	0.037
4	0.052	0.048	0.059	0.050	0.033
Mean	0.050	0.047	0.053	0.046	0.033
		Site Mean	0.046		

State: Massachusetts
County: Hampshire Setting: Rural
City: Amherst Land Use:Agricultural

Hour	May	June	July	August	Sept.
9	0.033	0.030	0.032	0.024	0.015
10	0.037	0.036	0.040	0.029	0.022
11	0.042	0.039	0.043	0.037	0.026
12	0.045	0.040	0.047	0.040	0.028
1	0.046	0.042	0.049	0.041	0.030
2	0.047	0.042	0.049	0.043	0.029
3	0.047	0.043	0.049	0.043	0.028
4	0.046	0.041	0.048	0.040	0.027
Mean	0.043	0.039	0.045	0.037	0.026
		Site Mean	0.038		

State: Massachusetts
County: Hampshire Setting: Rural
City: Ware Land Use:Forest

Hour	May	June	July	August	Sept.
9	0.042	0.038		0.034	0.026
10	0.046	0.043		0.040	0.030
11	0.048	0.048		0.045	0.033
12	0.051	0.050		0.046	0.035
1	0.051	0.049		0.049	0.037
2	0.051	0.050		0.051	0.039
3	0.051	0.049		0.050	0.039
4	0.051	0.049		0.049	0.037
Mean	0.049	0.047		0.046	0.035
		Site Mean	0.044		

State: Massachusetts
County: Middlesex Setting: Rural
City: Sudbury Land Use: Agricultural

Hour	May	June	July	August	Sept.
9	0.028	0.033	0.041	0.034	0.020
10	0.030	0.039	0.051	0.041	0.027
11	0.030	0.044	0.058	0.045	0.031
12	0.031	0.044	0.059	0.047	0.032
1	0.031	0.045	0.064	0.048	0.034
2	0.032	0.045	0.062	0.049	0.034
3	0.032	0.045	0.059	0.048	0.033
4	0.031	0.042	0.056	0.043	0.030
Mean	0.031	0.042	0.056	0.044	0.030
		Site Mean	0.041		

State: Massachusetts
County: Plymouth Setting: Suburban
City: Scituate Land Use: Residential

Hour	May	June	July	August	Sept.
9	0.039	0.041	0.026	0.030	0.019
10	0.041	0.045	0.031	0.036	0.023
11	0.043	0.048	0.036	0.042	0.027
12	0.045	0.049	0.040	0.045	0.030
1	0.045	0.050	0.042	0.049	0.029
2	0.046	0.050	0.042	0.048	0.029
3	0.044	0.050	0.042	0.046	0.030
4	0.044	0.050	0.041	0.044	0.028
Mean	0.043	0.048	0.038	0.043	0.027
		Site Mean	0.040		

State Connecticut City Greenwich
County Fairfield Setting Suburban
Site Greenwich Pt. Park Land Use Residential

Hour	May	June	July	Aug.	Sept
9	0.036	0.039	0.037	0.030	0.023
10	0.040	0.049	0.045	0.036	0.029
11	0.045	0.055	0.054	0.043	0.034
12	0.050	0.060	0.058	0.052	0.038
13	0.055	0.066	0.068	0.057	0.040
14	0.057	0.066	0.076	0.062	0.041
15	0.054	0.064	0.077	0.061	0.041
16	0.050	0.060	0.075	0.057	0.038
Mean	0.048	0.057	0.061	0.050	0.036
	Monthly Mean		0.050		

State Connecticut City Danbury
County Fairfield Setting Suburban
Site W. Connecticut State U. Land Use Residential

Hour	May	June	July	Aug.	Sept
9	0.041	0.041	0.042	0.030	0.023
10	0.047	0.046	0.049	0.038	0.030
11	0.049	0.051	0.054	0.044	0.033
12	0.052	0.055	0.057	0.049	0.035
13	0.054	0.057	0.062	0.053	0.036
14	0.055	0.060	0.065	0.054	0.036
15	0.054	0.059	0.066	0.056	0.036
16	0.052	0.058	0.065	0.055	0.031
Mean	0.051	0.053	0.058	0.047	0.033
Monthly Mean			0.048		

State Connecticut City Stratford
County Fairfield Setting Suburban
Site USCG Lighthouse Land Use Residential

Hour	May	June	July	Aug.	Sept
9	0.038	0.041	0.047	0.038	0.030
10	0.045	0.048	0.053	0.042	0.034
11	0.053	0.058	0.064	0.051	0.038
12	0.056	0.067	0.076	0.058	0.042
13	0.059	0.074	0.082	0.064	0.045
14	0.061	0.075	0.084	0.066	0.046
15	0.062	0.073	0.083	0.067	0.047
16	0.060	0.067	0.079	0.065	0.044
Mean	0.054	0.063	0.071	0.056	0.041
Monthly Mean			0.057		

State Connecticut City Middletown
County Middlesex Setting Suburban
Site Conn. Valley Hosp. Land Use Agricultural

Hour	May	June	July	Aug.	Sept
9	0.041	0.043	0.041	0.031	0.026
10	0.047	0.048	0.050	0.038	0.032
11	0.051	0.054	0.057	0.048	0.037
12	0.054	0.059	0.062	0.051	0.041
13	0.057	0.060	0.066	0.054	0.041
14	0.057	0.059	0.068	0.055	0.039
15	0.057	0.063	0.071	0.055	0.037
16	0.054	0.062	0.068	0.052	0.035
Mean	0.052	0.056	0.060	0.048	0.036
Monthly Mean			0.051		

State	Connecticut		City	Madison	
County	New Haven		Setting	---	
Site	Hammonasset State Park		Land Use	---	
Hour	May	June	July	Aug.	Sept
9	0.041	0.042	0.038	0.030	0.026
10	0.045	0.047	0.045	0.035	0.030
11	0.047	0.055	0.050	0.039	0.034
12	0.054	0.061	0.055	0.046	0.037
13	0.055	0.066	0.061	0.048	0.040
14	0.055	0.070	0.062	0.048	0.041
15	0.057	0.071	0.062	0.048	0.041
16	0.057	0.068	0.058	0.050	0.039
Mean	0.051	0.060	0.054	0.043	0.036
Monthly Mean			0.049		

State	Connecticut		City	Groton	
County	New London		Setting	Suburban	
Site	Univ. of Conn.		Land Use	Residential	
Hour	May	June	July	Aug.	Sept
9	0.044	0.046	0.040	0.034	0.031
10	0.047	0.050	0.045	0.040	0.035
11	0.051	0.059	0.051	0.046	0.039
12	0.055	0.065	0.056	0.050	0.043
13	0.060	0.070	0.059	0.051	0.048
14	0.061	0.075	0.060	0.054	0.049
15	0.060	0.075	0.064	0.056	0.050
16	0.060	0.070	0.064	0.055	0.047
Mean	0.055	0.064	0.055	0.048	0.043
Monthly Mean			0.053		

State	Connecticut		City	Stafford	
County	Tolland		Setting	Rural	
Site	Shenipsit State Forest		Land Use	Forest	
Hour	May	June	July	Aug.	Sept
9	0.042	0.042	0.044	0.033	0.028
10	0.046	0.046	0.049	0.038	0.031
11	0.047	0.050	0.055	0.043	0.035
12	0.050	0.052	0.056	0.047	0.037
13	0.051	0.051	0.059	0.048	0.039
14	0.051	0.051	0.062	0.047	0.037
15	0.053	0.051	0.060	0.046	0.036
16	0.052	0.051	0.058	0.046	0.033
Mean	0.049	0.049	0.055	0.044	0.035
Monthly Mean			0.046		

State	Maine		City	Cape Elizabeth	
County	Cumberland		Setting	Rural	
Site	Shelter Site		Land Use	Residential	
Hour	May	June	July	Aug.	Sept
9	0.042	0.039	0.032	0.034	0.027
10	0.045	0.042	0.034	0.039	0.028
11	0.048	0.046	0.038	0.042	0.030
12	0.049	0.048	0.042	0.045	0.033
13	0.051	0.049	0.046	0.048	0.035
14	0.054	0.052	0.048	0.051	0.037
15	0.054	0.054	0.049	0.051	0.039
16	0.053	0.054	0.051	0.050	0.040
Mean	0.050	0.048	0.043	0.045	0.034
Monthly Mean			0.044		

State	Maine		City	---	
County	Franklin		Setting	Rural	
Site	Sugarloaf Mountain		Land Use	---	
Hour	May	June	July	Aug.	Sept
9	0.050	0.042	0.038	0.037	0.034
10	0.049	0.042	0.038	0.037	0.034
11	0.049	0.042	0.039	0.038	0.033
12	0.049	0.043	0.039	0.038	0.033
13	0.049	0.043	0.039	0.039	0.035
14	0.050	0.044	0.040	0.040	0.035
15	0.050	0.044	0.041	0.040	0.035
16	0.051	0.044	0.042	0.041	0.035
Mean	0.050	0.043	0.040	0.039	0.034
Monthly Mean			0.041		

State	Maine		City	---	
County	Franklin		Setting	Rural	
Site	Sugarloaf Mtn. Base		Land Use	Mobile	
Hour	May	June	July	Aug.	Sept
9			0.031	0.033	0.029
10			0.032	0.035	0.030
11			0.032	0.035	0.033
12			0.032	0.035	0.033
13			0.033	0.036	0.033
14			0.034	0.036	0.033
15			0.035	0.036	0.032
16			0.036	0.036	0.032
Mean			0.033	0.035	0.032
Monthly Mean			0.033		

State Maine
County Hancock
Site McFarland Hill, Arcadia

City ---
Setting Rural
Land Use Residential

Hour	May	June	July	Aug.	Sept
9	0.043	0.038	0.031	0.033	0.029
10	0.044	0.040	0.034	0.036	0.032
11	0.045	0.041	0.035	0.038	0.033
12	0.046	0.042	0.036	0.039	0.034
13	0.046	0.045	0.038	0.039	0.035
14	0.046	0.045	0.038	0.040	0.034
15	0.046	0.046	0.040	0.039	0.035
16	0.046	0.047	0.041	0.039	0.035
Mean	0.045	0.043	0.037	0.038	0.033
Monthly Mean			0.039		

State Maine
County Hancock
Site Bald Mtn., Dedham

City ---
Setting Rural
Land Use Agriculture

Hour	May	June	July	Aug.	Sept
9	0.042	0.038	0.033	0.034	0.030
10	0.044	0.039	0.035	0.037	0.031
11	0.047	0.041	0.037	0.039	0.032
12	0.047	0.042	0.038	0.039	0.034
13	0.047	0.043	0.040	0.040	0.034
14	0.047	0.044	0.041	0.041	0.035
15	0.047	0.044	0.040	0.040	0.034
16	0.046	0.045	0.041	0.039	0.034
Mean	0.046	0.042	0.038	0.039	0.033
Monthly Mean			0.040		

State Maine
County Kennebec
Site Gardiner

City Gardiner
Setting Suburban
Land Use Residential

Hour	May	June	July	Aug.	Sept
9	0.040	0.037	0.029	0.033	0.024
10	0.042	0.040	0.033	0.037	0.028
11	0.045	0.040	0.036	0.039	0.031
12	0.045	0.043	0.040	0.039	0.032
13	0.047	0.043	0.041	0.041	0.033
14	0.047	0.044	0.042	0.041	0.033
15	0.048	0.044	0.042	0.042	0.033
16	0.047	0.045	0.041	0.040	0.031
Mean	0.045	0.042	0.038	0.039	0.031
Monthly Mean			0.039		

State	Maine		City	---	
County	Knox		Setting	Rural	
Site	Isle Au Haut		Land Use	---	
Hour	May	June	July	Aug.	Sept
9	0.037	0.040	0.036	0.038	0.029
10	0.040	0.042	0.038	0.041	0.031
11	0.046	0.043	0.039	0.044	0.034
12	0.050	0.046	0.043	0.047	0.035
13	0.053	0.048	0.046	0.048	0.036
14	0.054	0.048	0.049	0.049	0.038
15	0.055	0.051	0.050	0.052	0.039
16	0.057	0.050	0.048	0.053	0.040
Mean	0.049	0.046	0.044	0.047	0.035
Monthly Mean			0.044		

State	Maine		City	---	
County	Knox		Setting	---	
Site	Port Clyde		Land Use	---	
Hour	May	June	July	Aug.	Sept
9	0.041	0.039	0.030	0.032	0.029
10	0.042	0.042	0.032	0.036	0.031
11	0.044	0.044	0.035	0.039	0.033
12	0.047	0.046	0.039	0.042	0.035
13	0.048	0.047	0.043	0.044	0.037
14	0.049	0.051	0.045	0.047	0.039
15	0.049	0.051	0.047	0.047	0.041
16	0.049	0.052	0.046	0.047	0.041
Mean	0.046	0.047	0.040	0.042	0.036
Monthly Mean			0.042		

State	Maine		City	---	
County	York		Setting	Suburban	
Site	Kennebunkport		Land Use	Residential	
Hour	May	June	July	Aug.	Sept
9			0.030	0.031	0.022
10			0.036	0.037	0.025
11			0.040	0.041	0.028
12			0.046	0.046	0.030
13			0.048	0.047	0.033
14			0.050	0.048	0.034
15			0.050	0.048	0.035
16			0.050	0.048	0.034
Mean			0.044	0.043	0.030
Monthly Mean			0.039		

State	Maine			City	York	
County	York			Setting	---	
Site	Nubble Point			Land Use	---	
	Hour	May	June	July	Aug.	Sept
	9			0.032	0.035	0.022
	10			0.039	0.040	0.025
	11			0.046	0.043	0.028
	12			0.050	0.046	0.030
	13			0.049	0.045	0.032
	14			0.051	0.045	0.034
	15			0.051	0.046	0.034
	16			0.047	0.049	0.033
	Mean			0.046	0.044	0.030
		Monthly Mean		0.040		

State	New Hampshire			City	Berlin	
County	Coos			Setting	Urban and City Center	
Site	Lancaster Street Trailer			Land Use	Residential	
	Hour	May	June	July	Aug.	Sept
	9	0.037	0.033	0.035	0.031	0.025
	10	0.039	0.035	0.038	0.037	0.026
	11	0.039	0.034	0.040	0.039	0.029
	12	0.040	0.037	0.040	0.039	0.030
	13	0.039	0.037	0.041	0.039	0.030
	14	0.040	0.035	0.040	0.039	0.030
	15	0.041	0.036	0.041	0.039	0.030
	16	0.041	0.036	0.042	0.038	0.029
	Mean	0.040	0.035	0.040	0.038	0.029
		Monthly Mean		0.036		

State	New Hampshire			City	---	
County	Merrimack			Setting	---	
Site	So. Bow and Dunbarton Rd., Bow			Land Use	---	
	Hour	May	June	July	Aug.	Sept
	9			0.037	0.039	0.026
	10			0.042	0.041	0.029
	11			0.047	0.044	0.031
	12			0.052	0.045	0.034
	13			0.053	0.047	0.035
	14			0.052	0.046	0.036
	15			0.052	0.046	0.036
	16			0.053	0.045	0.035
	Mean			0.049	0.044	0.033
		Monthly Mean		0.042		

State New Hampshire
County Rockingham
Site Rye Harbor State Park
City ---
Setting Suburban
Land Use Residential

Hour	May	June	July	Aug.	Sept
9	0.041	0.042	0.034	0.037	0.025
10	0.047	0.045	0.038	0.042	0.027
11	0.049	0.048	0.046	0.047	0.030
12	0.052	0.051	0.051	0.051	0.033
13	0.050	0.053	0.056	0.054	0.035
14	0.051	0.056	0.057	0.053	0.037
15	0.051	0.055	0.059	0.053	0.037
16	0.050	0.055	0.055	0.050	0.034
Mean	0.049	0.051	0.050	0.048	0.032
Monthly Mean			0.046		

State Rhode Island
County Kent
Site Parkfield
City West Grenwich
Setting Rural
Land Use Agricultural

Hour	May	June	July	Aug.	Sept
9	0.050	0.048	0.044	0.037	0.030
10	0.054	0.054	0.047	0.043	0.035
11	0.056	0.059	0.052	0.049	0.040
12	0.057	0.061	0.055	0.054	0.043
13	0.058	0.067	0.058	0.058	0.045
14	0.059	0.070	0.061	0.059	0.045
15	0.060	0.072	0.063	0.060	0.045
16	0.059	0.070	0.063	0.058	0.042
Mean	0.057	0.063	0.055	0.052	0.041
Monthly Mean			0.054		

State Vermont
County Bennington
Site ---
City Bennington
Setting Rural
Land Use Agricultural

Hour	May	June	July	Aug.	Sept
9	0.046	0.041	0.038	0.031	0.026
10	0.047	0.044	0.044	0.035	0.031
11	0.049	0.047	0.048	0.038	0.035
12	0.051	0.048	0.049	0.039	0.036
13	0.053	0.046	0.050	0.042	0.036
14	0.052	0.046	0.049	0.042	0.035
15	0.055	0.047	0.048	0.041	0.034
16	0.055	0.048	0.049	0.041	0.031
Mean		0.046	0.047	0.039	0.033
Monthly Mean			0.041		

State	Vermont			City	Burlington	
County	Chittenden			Setting	Rural	
Site	---			Land Use	Residential	
	Hour	May	June	July	Aug.	Sept
	9	0.037	0.038	0.034	0.034	0.026
	10	0.039	0.039	0.038	0.037	0.030
	11	0.041	0.039	0.040	0.040	0.031
	12	0.044	0.041	0.041	0.042	0.034
	13	0.046	0.042	0.041	0.045	0.035
	14	0.047	0.043	0.042	0.045	0.035
	15	0.047	0.043	0.043	0.044	0.036
	16	0.047	0.041	0.041	0.042	0.032
	Mean	0.044	0.041	0.040	0.041	0.032
		Monthly Mean		0.040		